

Student activities

Activity 1: Time traveller

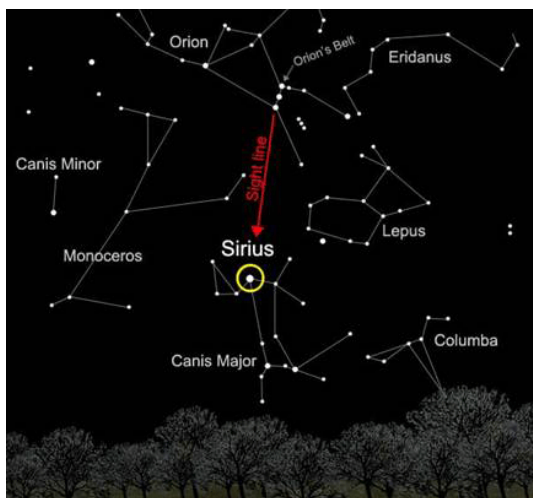
Introduction

Distances in astronomy are often very difficult to comprehend because they are so large. For example, the distance from the star Sirius to Earth is 84 320 000 000 000 km. This distance is too large for most people to imagine or understand. There are ways to make such large numbers more manageable. For instance, it is easier to understand and work with 15 years than it is with 5 475 days, even though they both represent the same amount of time. A 'Year' is a much larger unit than a 'Day'. The same type of thing can be done with distances using a measurement called a 'Light Year' (abbreviated to l.y.).

A light year is defined as the distance that a light beam will travel in one year. To calculate how far 1 l.y. is in km, we use the fact that the speed of light is 300 000 km per second. To calculate a light year, we multiply the number of seconds in a year by 300,000 and we get 9 461 000 000 000 km. This is the same as travelling around the world 236 million times. Using this unit, the distance to the star Sirius is now a more manageable 9 l.y.

The light year is also important because it tells us about the time lag involved in communicating over the large distances involved in astronomy. It takes time for light to reach us from a distant star so when we look at the night sky, we are looking into the past. For example, we see the star Sirius as it was 9 years ago. Since radio signals also travel at the speed of light, this has implications for communication with space craft.

This activity introduces the concept of 'Light Years' as a standard astronomical distance unit. It can be used as a mathematical follow-up to a solar system scale model, and as an introduction to the stars or constellations. Students will walk heel-to-toe for one minute, measure the distance they walked and use that as an analogy for the distance that light travels in a specified time. This distance is then called a 'student minute'. The students will need approximately 20 to 30 metres for this activity.



Sirius, the closest star visible with the naked eye
Image credit: NASA/JPL www.jpl.nasa.gov

Time Traveller worksheet

Introduction

A light year is defined as the distance that a light beam will travel in one year. To calculate how far one Light Year is in km, we use the fact that light travels 300 000 km per second. The number of seconds in a year is 31,557,600. To calculate a light year, we multiply the number of seconds in a year by 300 000 and we get 9 461 000 000 000 km. This is the same as travelling around the world 236 million times! In the following activity, you will measure the distance you can walk for one minute and calculate a new unit called the 'student minute'.

What you need

- A watch with a second hand or a stop watch
- A long metric tape (30m) or a trundle wheel
- A calculator

What to do

In pairs:

1. Find a large space you can use either inside or outside (approx. 20 to 30 metres).
2. Starting at one end of the space you have chosen, walk heel-to-toe for exactly one minute. When you stop, mark your position.
3. Measure how far you walked to the nearest metre, and record this distance in the table below.
4. Repeat steps 2 and 3 three more times.
5. Calculate the average of the three measurements and record it in the table.



The average you calculated is the distance you can walk heel-to-toe in one minute. We will call that distance a 'student minute'.

Trial	Distance Walked
Trial 1	metres
Trial 2	metres
Trial 3	metres
Average $(1+2+3)/3$	metres
My student minute is...	metres

Questions

1. Are all student minutes the same?
2. How are student minutes similar to a light year?
3. How many metres in 3 student minutes?
4. How many of your student minutes are there in 5000 metres?
5. If you could not travel any faster than your heel-to-toe walking pace, how long would it take you to travel:
 - a) 5000m?
 - b) 1km?
 - c) 500km?
 - d) to the moon?
6. Find out the speed that a rocket would need to travel to reach the Moon and how long it would take to get there travelling at this speed.
7. How far is 'Sirius', the brightest star in our sky, from Earth in light years?
8. How far away are the second and third brightest stars from Earth in light years?

Activity 2: Making 2-D models of constellations

Introduction

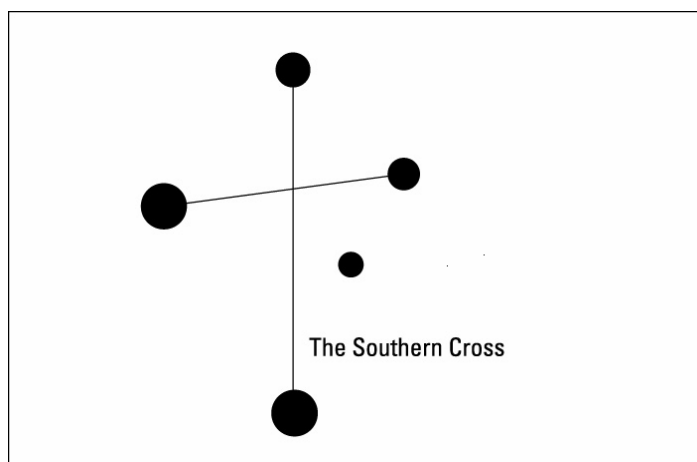
This activity helps students to become familiar with the main constellations. The 2D models can be used as a temporary display around the classroom to help you remember the names and patterns of the constellations.

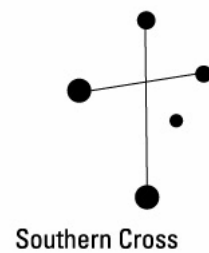
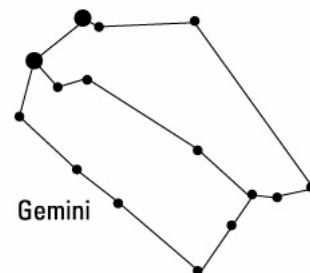
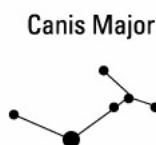
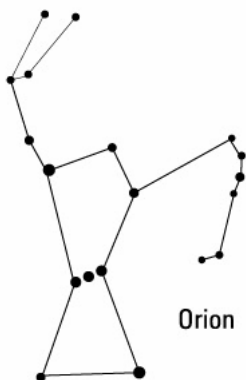
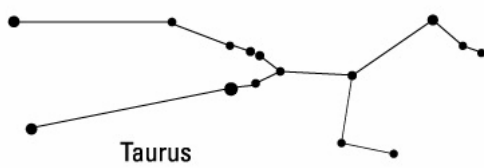
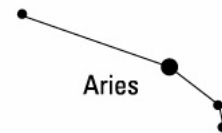
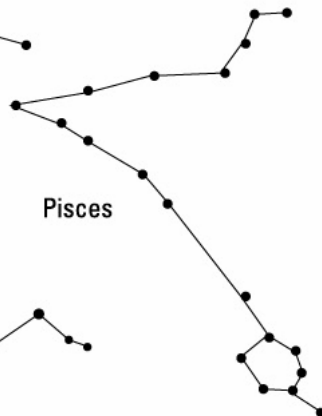
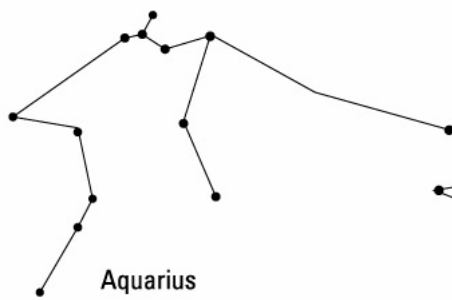
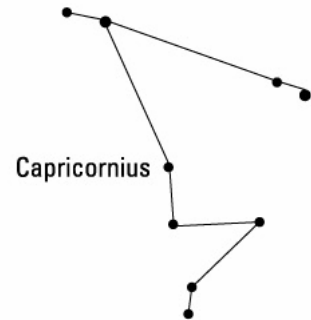
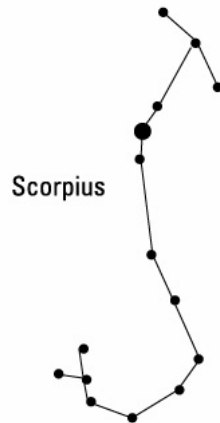
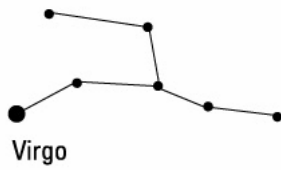
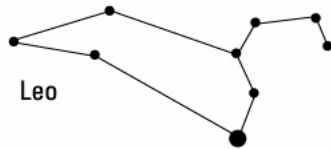
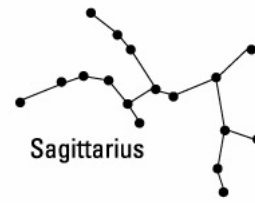
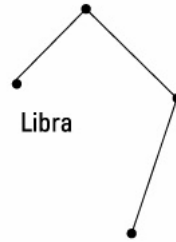
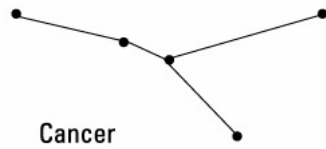
What you need

- a container with strips of paper, each with the name of a main constellations
- A3 black cardboard (one per student)
- sticky tape or glue
- white chalk, pencil or crayon
- worksheet with the main constellations
- aluminium foil

What to do

1. Choose a constellation from the container.
2. With aluminium foil, make 3-D stars by rolling the foil into balls and sticking these onto black cardboard in the shape of their constellation.
3. With a white pencil or crayon, draw imaginary lines joining the stars so that the constellations can be more easily identified.
4. With the aluminium foil, cut out the letters that make up the name of the constellation and label the constellation on the cardboard.
5. Place the labelled constellations along the back wall so that you have your own night sky in the classroom. You may want to use a star map as a reference to position the constellations as they would appear for a particular month at 8pm (AEST). Star maps are available online from the Planetarium website: <http://museumvictoria.com.au/Planetarium/DiscoveryCentre/Sky-Maps/> or from Skymaps.com: <http://www.skymaps.com/downloads.html>





Activity 3: Making a 3-D model of the Southern Cross

Background information

When we look at the Southern Cross, the five stars appear to form a cross or kite shape. It is important to remember however, that although stars look close together in the sky, they may actually be hundreds of light years apart because their distances from Earth vary. The 'shape' they form is only seen from Earth. If we could view the Southern Cross from somewhere else in space, far away from our Solar System, it may not look anything like the shape we see from Earth.

In this activity, students make a three dimensional model of the stars in the Southern Cross. The model uses wooden skewers to mount the 'stars'. As this can be dangerous, students should be carefully supervised until the models are completed and the polystyrene/clay/plasticine balls are pressed onto the ends of the skewers. If necessary, the skewers could be pre-cut to the appropriate sizes and already labelled.

The distances to the stars in the Southern Cross given in the table (below) were obtained from the Hipparcos satellite, which was specially designed for astrometry (measuring the distance and motion of stars). The satellite gathered data from 1989 to 1993. The Hipparcos mission has greatly increased the accuracy of known stellar distances (by a factor of 10), and also increased the number of stars listed with distance measurements.

The apparent magnitude of a star indicates its brightness as it appears from Earth. Magnitudes are defined so that the brighter the star, the smaller its magnitude in quantitative terms. For example, the Sun has a magnitude of -26, the Full Moon has a magnitude of -13 and Venus has a magnitude of -4. The brightest star in the night sky, Sirius, has a magnitude of -1.5, while the faintest star visible to the naked eye has a magnitude of 6.

Within constellations, the brightest stars are labelled with letters of the Greek alphabet. The brightest is generally α (alpha), the second brightest is β (beta), then γ (gamma), δ (delta), ϵ (epsilon) and so on.

The table below indicates distances and magnitudes for the five main stars in the constellation of Crux, the Southern Cross.

Name of star (brightest to faintest)	Distances measured by Hipparcos satellite	Apparent Magnitude	Colour (type of star)
α (Alpha) Crucis	321 light years	0.8	Blue-white
β (Beta) Crucis	352 light years	1.2	Blue-white
γ (Gamma) Crucis	88 light years	1.6	Red
δ (Delta) Crucis	364 light years	2.8	Blue-white
ϵ (Epsilon) Crucis	228 light years	3.6	Orange

The apparent magnitude (brightness) of a star is determined by the amount of energy it is radiating and its distance from the Earth. However, as the table above indicates, a star's brightness doesn't necessarily mean that it is closer to us. The brightest star in the Southern Cross when viewed from Earth, α (Alpha) Crux, is further away from us than the faintest of the five main stars – ϵ (Epsilon) Crux. Note that on star maps, bright stars are usually indicated by large dots.

The 3-D model will demonstrate the relative distance from Earth and the colour (temperature) of each star. (Blue stars are hotter than red stars). Brightness can be approximated by gluing an appropriate amount of 'sparkle' to each star. Relative sizes will not be modelled as several of the stars are actually double stars.



The Milky Way near the Southern Cross

<http://www.nasaimages.org>

A 3-D model of the Southern Cross

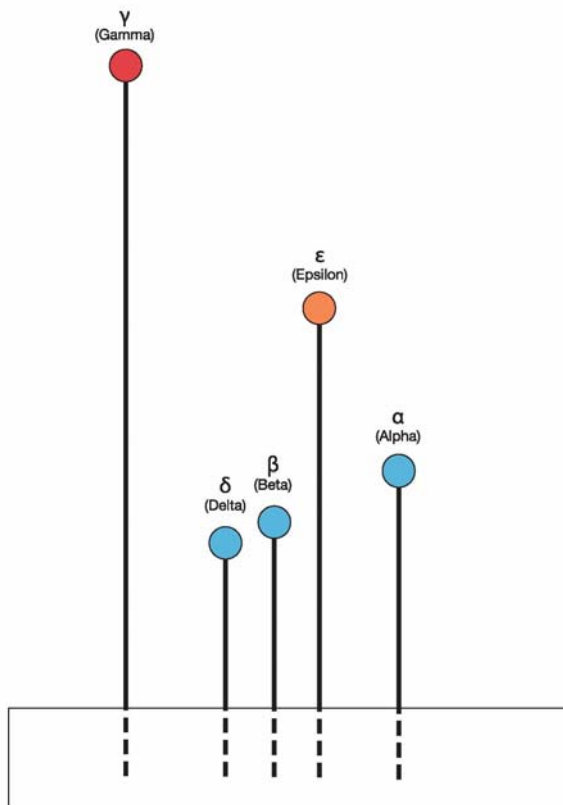
Student Introduction

When we look at the Southern Cross, the five stars appear to form a cross or kite shape in the night sky. It is important to remember however, that although stars look close together in the sky, they may actually be hundreds of light years apart because their distance from Earth varies. The 'shape' they form is only seen from Earth. If we could view the Southern Cross from somewhere else in space, far away from our Solar System, it may not look anything like the shape it looks like from Earth.

A 3-D model of the Southern Cross will enable us to see what the five main stars would look like if viewed from elsewhere in space.

What you need

- 5 wooden skewers/pieces of dowel/balloon sticks, each 25 cm long
- five small polystyrene, clay or plasticine balls, of equal size
- A4 flat polystyrene sheet (about 3 cm thick)
- orange and red cellophane paper
- aluminium foil or blue cellophane
- sticky tape or glue
- a small amount of silver 'sparkle'
- worksheet with the 2-D diagram of the Southern Cross



Side view of the Southern Cross model

What to do

1. Stick the worksheet with the 2-D diagram of the Southern Cross flat onto the Polystyrene sheet.
2. Mark 2 cm from the point of each skewer to show how far to push the skewer into the Polystyrene sheet.
3. Refer to the diagram above and the table below. Work out the distance of each star from Earth for your model according to the scale of 1 cm : 20 light years. Enter your results in the third column of the table.

Name of star (from brightest to faintest)	Distance from Earth	Distance from Earth, with scale of 1 cm : 20 ly
α (Alpha) Crucis	321 light years	16 cm
β (Beta) Crucis	352 light years	___ cm
γ (Gamma) Crucis	88 light years	___ cm
δ (Delta) Crucis	364 light years	___ cm
ϵ (Epsilon) Crucis	228 light years	___ cm

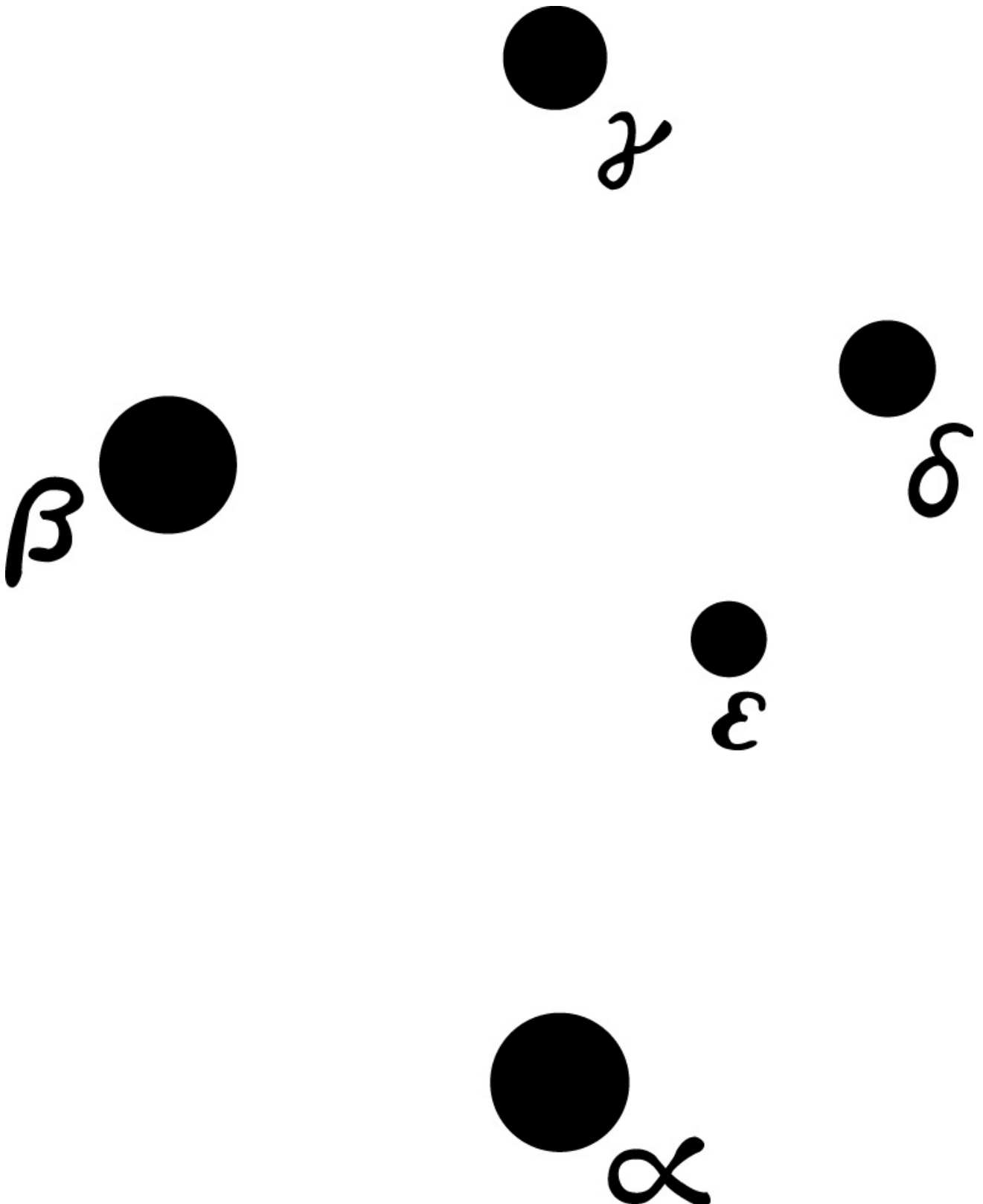
4. Let us say that in the model, Earth (=our viewing point) will be about 23 cm directly above the Polystyrene sheet. (This would be at the blunt end of one of your 25 cm skewers, after allowing 2cm for inserting it into the Polystyrene sheet.)
5. Label a skewer for each star. Measure the 'Distance from Earth' (Column 3) from the blunt end of each skewer. Cut off this amount of skewer and discard it.
6. Carefully sharpen the cut end of each skewer if necessary, and attach a ball ('star') to each.
7. Cover the balls representing α , β and δ in aluminium foil or blue cellophane using glue or sticky-tape. (They are blue-white stars).
8. Cover the ball representing γ in red cellophane and the ball representing ϵ in orange cellophane in the same way.
9. Place the skewers in their correct positions on the polystyrene sheet. Push them in to a depth of 2 cm.
10. Glue an appropriate amount of 'sparkle' to each ball to indicate the relative brightness of each star. The names of the stars from α (Alpha) to ϵ (Epsilon) are in declining order of brightness.

You now have a 3-D model of the Southern Cross. When you look down on the model from above you can see the shape of the Southern Cross, as it looks from Earth. However, if you place your model on the table and walk around it, you will see the different shapes made by looking at the stars from different perspectives.

Optional

Draw the positions of the stars relative to each other from several perspectives. Now try to form a 'constellation' (or imaginary picture) that the stars might make when viewed from these different viewpoints. You will need a little imagination!

Southern Cross worksheet

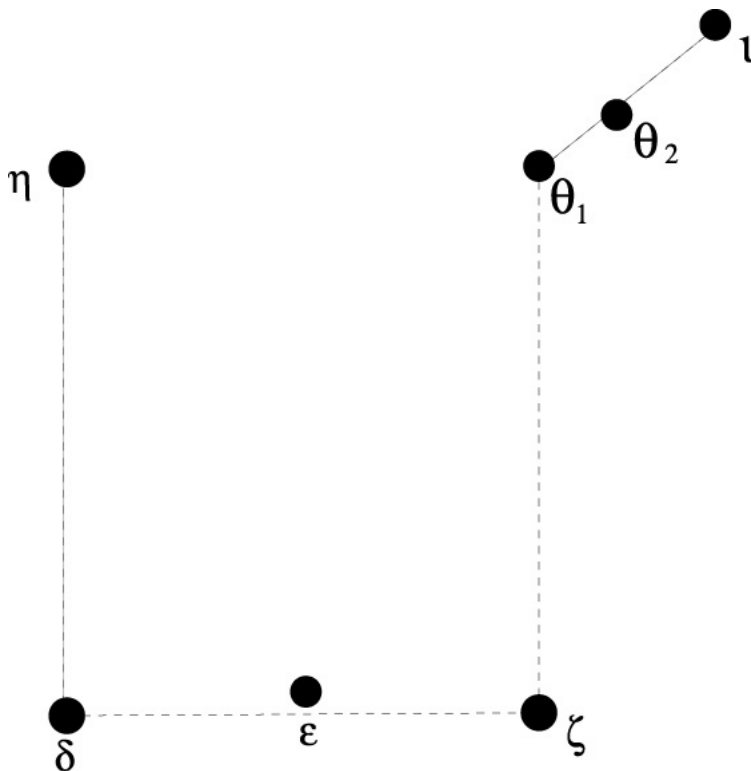


Activity 4: Making a 3-D model of the Saucepan in Orion

Background information

When we look at the night sky with a little imagination, the stars appear to form different shapes or constellations. It is important to remember however, that although stars look close together in the sky, they may actually be hundreds of light years apart because their distance from Earth varies. The 'shape' they form is only seen from Earth.

The constellation of Orion forms the shape of a hunter and can be seen high in the night sky during summer (in the Southern Hemisphere). It is a constellation that contains two famous deep sky wonders – the Orion Nebula and the Horsehead Nebula, and two supergiant stars – Betelgeuse and Rigel. In the Southern Hemisphere, Orion the Hunter appears to be upside down, as are many constellations because they were named by Northern Hemisphere observers. From Australia, Orion the Hunter is standing on his head when he's high in the night sky. The three stars in a row that make up Orion's belt (Mintaka (δ), Alnilam (ϵ) and Alnitak (ζ)) are also known as part of a saucepan shape that is the right way up in the Southern Hemisphere. These three stars make up the bottom of the saucepan. Eta Orionis (η) joins Mintaka (δ) to make one side, Theta 1 Orionis (θ^1) joins Alnitak (ζ) to make up the other side and Theta 2 Orionis (θ^2) and Iota Orionis (ι) make up the small handle.



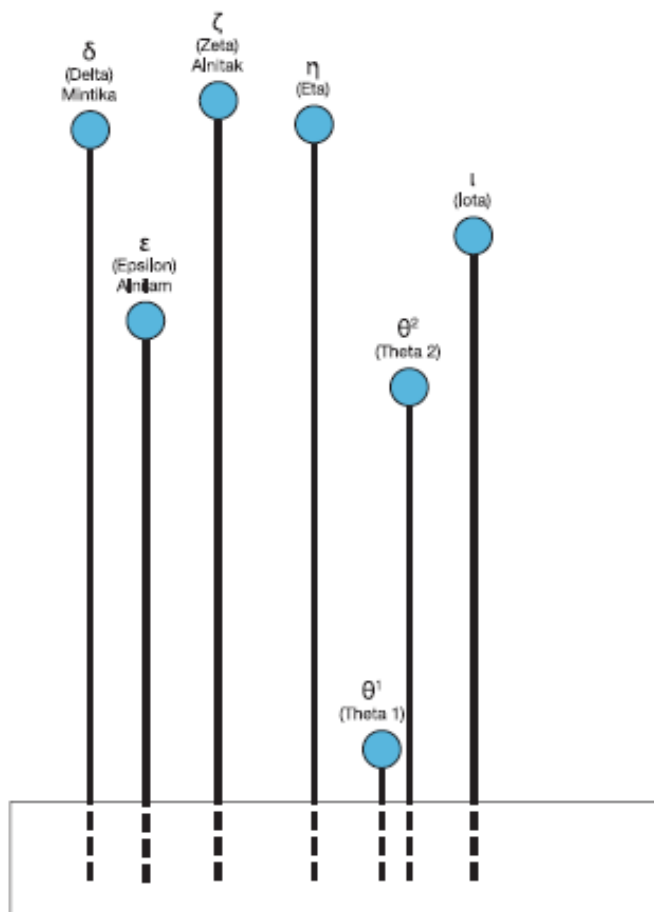
In the following activity, you will make a 3-D model of the Saucepan to get an idea of how the 'shape' of the Saucepan changes when seen from various perspectives in space.

The apparent magnitude of a star indicates its brightness as it appears from Earth. Magnitudes are defined so that the brighter the star, the smaller its magnitude in quantitative terms. For example, the Sun has a magnitude of -26, the Full Moon has a magnitude of -13 and Venus a magnitude of -4. The brightest star in the night sky, (Sirius), has a magnitude of -1.5, while the faintest star visible to the naked eye has a magnitude of 6.

The apparent magnitude (brightness) of a star is determined by its distance from the Earth and the amount of energy it is radiating. The 3-D model will demonstrate the relative distance of each star from Earth and that the stars are blue or blue-white in colour. Brightness can be approximated by gluing an appropriate amount of 'sparkle' to each 'star'. Relative sizes will not be modelled as most of the seven stars are actually multiple stars.

What you need

- 7 small, blue-white plasticine balls, of equal size
- 7 skewers/pieces of dowel/balloon sticks, each 25 cm long
- flat A4 sheet of polystyrene sheet, approximately 3 cm thick
- glue
- small amount of 'sparkle'
- A4 worksheet with 2-D diagram of the Saucepan in Orion



Side view of the Saucepan in Orion model

What to do

1. Stick the A4 worksheet with the 2-D diagram of the Saucepan in Orion flat onto the Polystyrene sheet.
2. Mark 2 cm from the point of each skewer to show how far to push the skewer into the Polystyrene sheet.
3. Refer to the diagram above and the table below. Work out the distance of each star from Earth for your model according to the scale 1cm : 150 light years. Enter your results in the fourth column of the table.

Name of star	Apparent Magnitude	Distance from Earth in light years	Distance from Earth with scale of 1cm : 150 ly
Iota Orionis ι	2.8	1325	9 cm
Eta Orionis η	3.4	901	___ cm
Delta Orionis δ (Mintaka)	2.3	915	___ cm
Epsilon Orionis ϵ (Alnilam)	1.7	1342	___ cm
Zeta Orionis ζ (Alnitak)	1.7	817	___ cm
Theta 1 Orionis θ^1	5.0	3260	___ cm
Theta 2 Orionis θ^2	5.1	1895	___ cm

4. Let us say that in the model, Earth (our viewing point) will be about 23 cm directly above the Polystyrene sheet. (This would be at the blunt end of one of your 25 cm skewers, after allowing 2 cm for inserting it into the Polystyrene sheet).
5. Label a skewer for each star. Measure the 'Distance from Earth' (Column 4) from the blunt end of each skewer. Cut off this amount and discard it.
6. Carefully sharpen the cut end of each skewer if necessary, and attach a blue-white plasticine ball ('star') to each.
7. Place the skewers in their correct positions on the polystyrene sheet(s). Push them in to a depth of 2 cm.
8. Glue an appropriate amount of 'sparkle' to each ball to indicate the relative brightness of each star. The second column in the table above indicates the Apparent Magnitude of each star – the lower the number, the brighter the star. Put most 'sparkle' on ϵ and ζ (Alnilam and Alnitak), and least on θ^2 (Theta 2 Orionis).

You now have a 3-D model of the Saucepan in Orion. When you look down on the model from above you can see the shape of the Saucepan, as it looks from Earth. However, if you place your model on the table and walk around it, you will see the different shapes made by looking at the stars from different perspectives.

Optional

- Draw the positions of the stars relative to each other from several perspectives. Now try to form a 'constellation' (or imaginary picture) that the stars might make when viewed from these different viewpoints. You will need a little imagination!
- Find a picture of the stars that make up Orion the Hunter. Find out the distance to the stars Rigel, Betelgeuse, Bellatrix and Saiph from Earth in light years. Using the scale 1cm = 150 light years (ly), add these stars to your model to make it look more like Orion the Hunter.
You might find the following web site useful:
<http://www.dibonsmith.com/constel.htm>
- Find out where the Orion Nebula and the Horsehead Nebula are positioned within this constellation and add these to your model. Use colourful cotton wool to represent the nebulae in your model.



Orion

<http://www.nasaimages.org>

Saucepan in Orion worksheet

